UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WESTERN GULF REGION

LOUIS P. MERRILL REGIONAL CONSERVATOR

HOW TO KNOW
GRASS

Prepared By B. W. Allred
Chief Regional Range Division
Fort Worth, Texas
September, 1947

For In-Service Use Only

REGION 4 250 11-19-48

...cript and for assistance in developing some of the illustrations.

To Dr. J. E. Weaver, Professor of Ecology, Lincoln, Nebraska, credit is given for helpful details on how plants grow, and for recommendations on height growth of short, mid and tall grasses.

The drawings were developed by Glenn Bilyeu and Lucille Kennedy, Soil Conservation Service, Region 4 Cartographic Division.

September 1947

HOW TO KNOW GRASSES

Index

Index (Continued)

HOW TO KNOW GRASSES

by B. W. Allred
Regional Chief of Range Division
Soil Conservation Service
Region 4

We need to know grasses better than we do. When we know them well enough to manage them right, they will yield more and livestock will do better. The soil will be preserved and management costs will go down. Run-down ranges like run-down cars are poor investments.

We have spent two hundred years breeding thick bodies on meat animals. Not much consideration was given to caring for the grasses that feed the animals, so much of our former excellent grassland has lost a great deal of its productivity. Highly bred animals become scrubby when they graze scrub pastures. When our animals are forced to graze scanty grassland, we cannot get from them the full yielding power of their inheritance; that is, unless we give them roughages and concentrates along with pasture. These supplements run production costs too high if they have to be fed very long. Green pasturage is 3 to 5 times cheaper than any other form of livestock forage.

It is just as necessary to know our chief grasses as it is to know different breeds of animals. So, it is equally important to know the requirements for growth and reproduction of key forage plants as it is to know how animals grow and reproduce. The better known grasses become, the easier it is to work out plans for maximum safe grazing.

Anyone who can tell different breeds of animals apart can learn to know one grass species from another. There are markings on animals that distinguish one from another -- also, there are markings or different characteristics which distinguish grasses, too.

There are several characteristics that make it easy to distinguish grasses from other plants. Stems are usually round although in Canada bluegrass and sandbur, and a few others, are somewhat flattened. Stems are generally hollow, or sometimes, as in bluestems, corn, sorghums and bamboos, the centers are packed with a pith-like filling. Grass stems are jointed and usually solid at the nodes or joints. Leaves are long and slender with outer veins usually paralleling the enlarged central vein or midrib. Leaves originate at the nodes and alternate on each side of the stem, clasping the stems in enveloping sheaths or boots. Grass leaves have three parts: blade, ligule, and sheath. The ligule, sometimes called a rainguard, is quite often membranous and usually clasps the stem firmly and keeps rain and dirt from fouling the sheath.

The protective chaffy covering around the flowers assumes varied forms in different grasses. In wheat the chaff breaks free in threshing, whereas in oats and Texas wintergrass, the inner chaffy material surrounding the grain remains attached. With corn the kernels on the cob are covered

with layers of husks. After shelling, the rough pitted part of the cob is the chaff that partly surrounds each kernel.

Knowing how plants grow helps to manage them so that they can produce most. Trees and shrubs grow differently from grasses and this difference gives grasses the advantage in forage production.

Usually with trees and shrubs, stems develop only at the nodes and leaf axils. Primary growth takes place only at tip end of the stem which is enveloped by protective rudimentary foliage leaves or bud scales. Therefore, a boy can cut his initials in a young tree trunk three feet from the ground and by the time he is a man his initials will still be three feet from the ground. The trunk and limbs enlarge in diameter, however, and this growth originates from secondary tissues in the lateral cambium, the active tissue which holds the circulatory system of trees and shrubs, called zylem and phloem.

Leaves of broadleafed trees and shrubs enlarge fairly uniformly and hence the large mature leaf has the same general outline as it did when it was small and new. Sometimes, however, the mature leaf may have grown larger on one side than the other. The leaves grow in size by cell increase and cell enlargement. New leaves may be only a few cells thick when freed from the bud and thickness may not increase in dense shade, but if grown in the sun leaves may become several cells thick and palisaded.

Roots grow at the tip behind a protective point that opens the way for the tender growing rootlet.

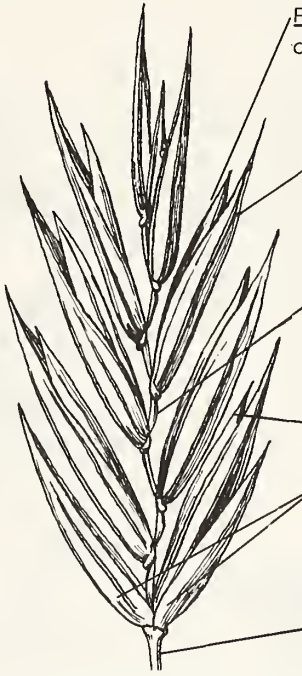
Growing tissue of grass is located in the lower part of the joint or swollen node. In the young grass the joints are crowded together similar to a telescoped fishing rod with immature leaves protruding beyond the buds and as each joint is extended its companion leaf unfolds from the center roll and falls into place beside the stem. The growing stem actually issues upward from the node much like lead issues from an automatic pencil. It rises inside the sheath and eventually breaks through the top of the boot (Harshberger, 1920).

Stems of sod-forming grasses like buffalograss, St. Augustine, and Bermudagrass break through the protective leaf sheath of the basal leaves and follow the ground surface, occasionally tagging down roots at the joints to secure the stolon and to form new plants. Grass grows by increasing number of cells and by cell enlargement.

Extension of grass stems and leaves is due to the singular growing zone or meristematic tissue, part being located in the enlarged base of the sheath and some of the rest in the swollen node. Because of this the cells just above some of the nodes sometimes stay soft and active after the rest of the internode has become mature. The clasping leaf sheaf at the node gives the major strength to tender stem, much like gauze wrappings give strength to a man's broken arm.

THE FLOWER OF THE GRASS IS CALLED A SPIKELET

DIAGRAM OF A GRASS SPIKELET



GENERALIZED GRASS SPIKELET

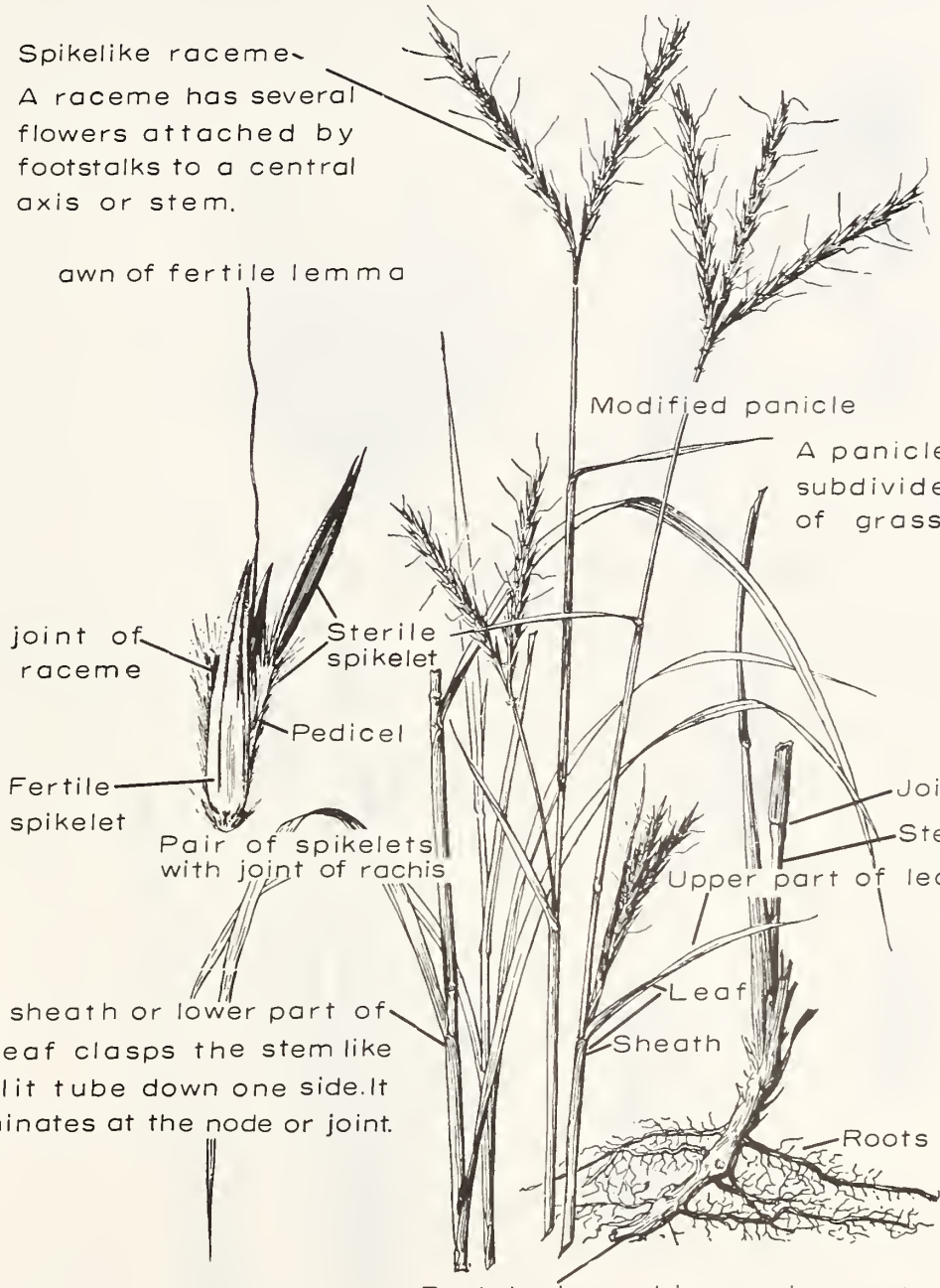
The spikelet has one or more flowers that are usually surrounded by two or more chaffy scales.

Grasses and sedges are the only plant families that have flowers in the form of spikelets. At flowering time the lodicules of grass swell and help to spread the surrounding scales. The anthers and stigmas push out beyond the scales. The anther bursts and the air currents scatter the pollen grains on the sticky stigma. The pollen grain produces a tube which grows down through the stigma to the ovary. The contents of the pollen tube fertilize the egg in the ovary and the seed is formed. *AFTER AGNES CHASE*

SIZE AVAILABLE 8X10½ 20X24 7/18/47 4-L-5679

BIG BLUESTEM,

Andropogon furcatus

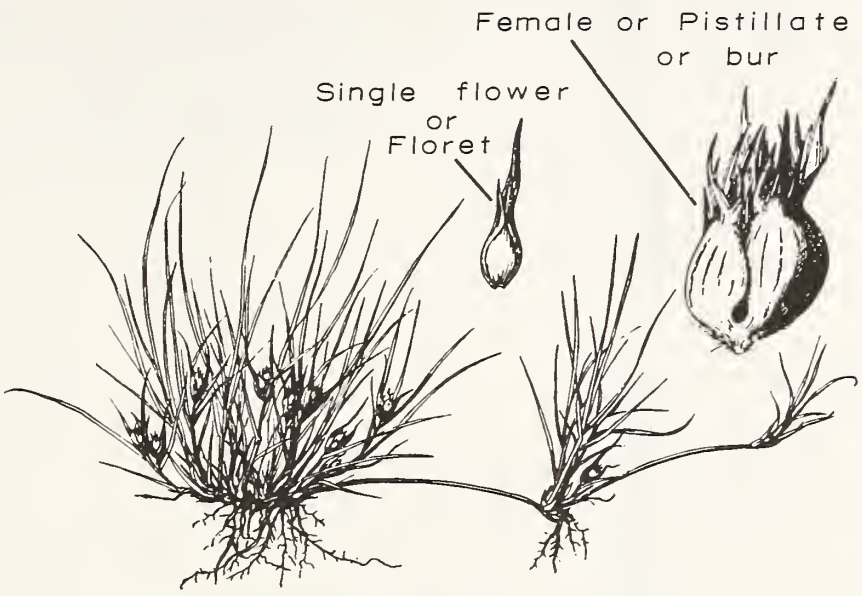


REPRODUCED IN PART FROM
U. S. DEPARTMENT OF AGRICULTURE
BULLETIN NO. 772.

SIZE AVAILABLE
8 X 10½
20 X 24

7/18/47 4-L-5681

BUFFALOGRASS,
Buchloe dactyloides



Female or Pistillate plants

Male or Staminate plants

REPRODUCED IN PART FROM
U.S. DEPARTMENT OF AGRICULTURE
BULLETIN NO. 772

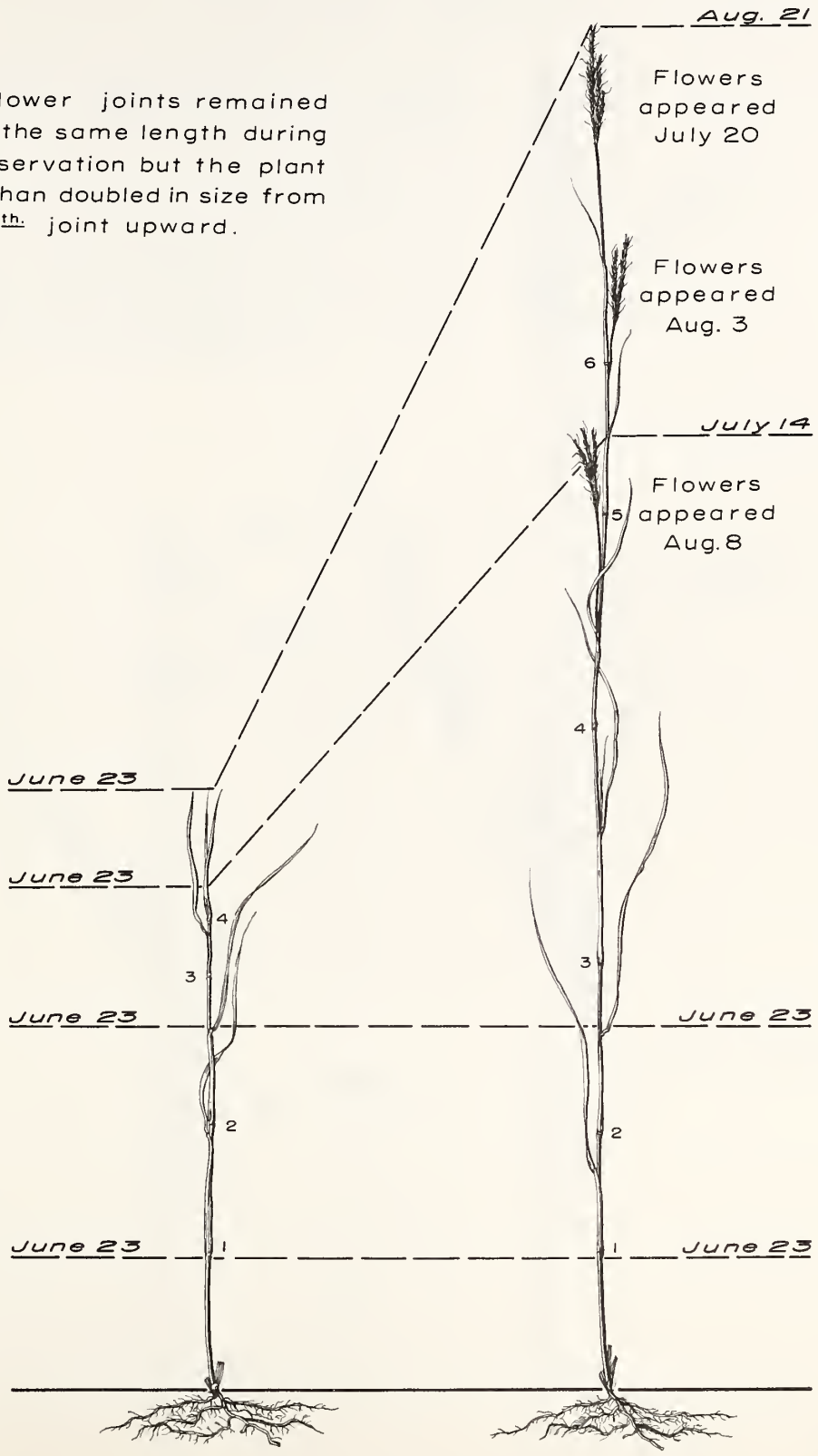
SIZE AVAILABLE
8 X 10 ½
20 X 24

7/18/47 4-L-5680

BIG BLUESTEM SEEDSTALK

ON JUNE 23 AND AGAIN ON AUGUST 21

Four lower joints remained about the same length during the observation but the plant more than doubled in size from the 4th. joint upward.

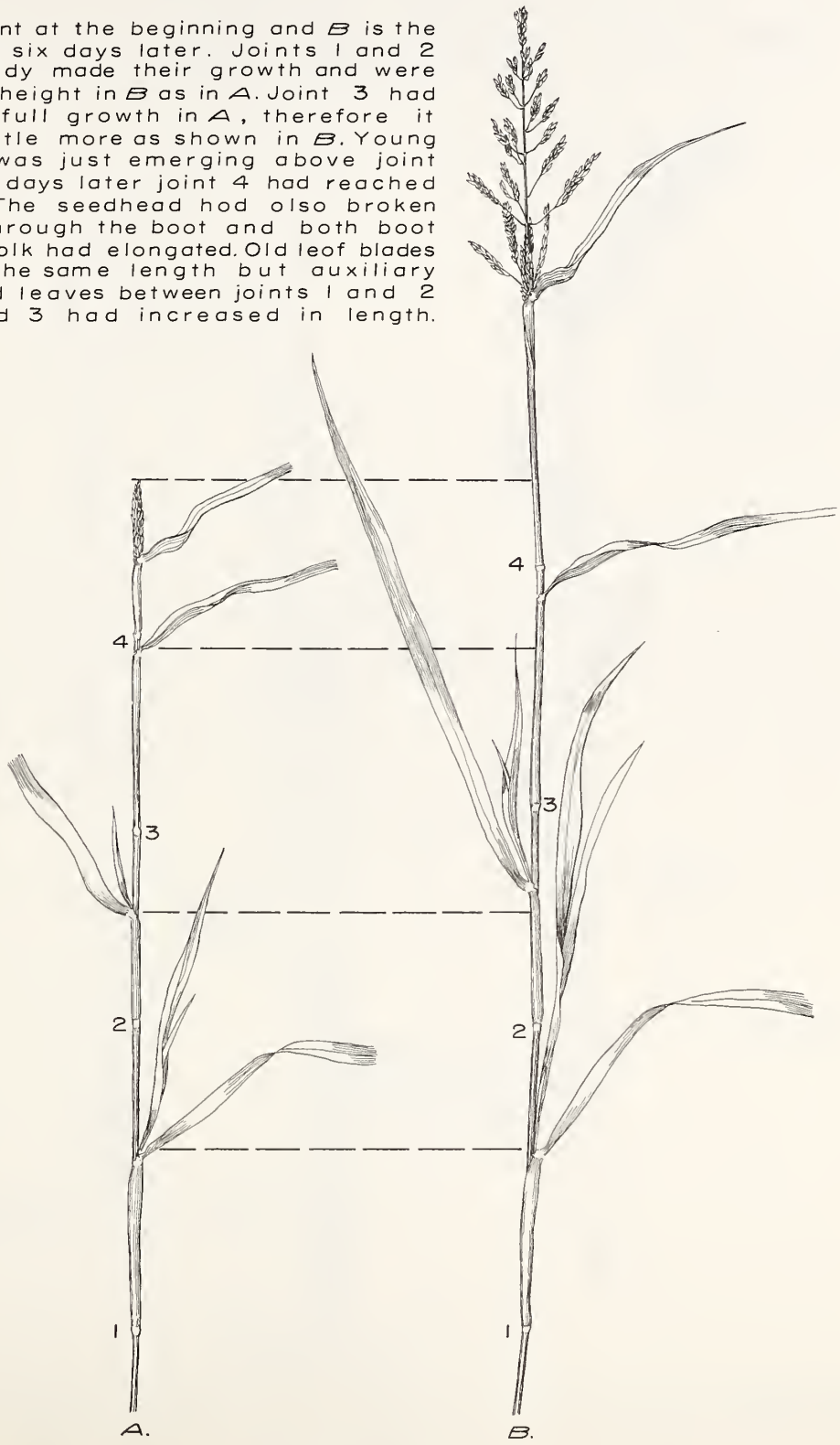


Available sizes
8" X 10½" – 20" X 24"

G.L.B. 9-4-47 4-L-5779

GROWTH OF JOHNSONGRASS IN SIX DAYS

A is the plant at the beginning and *B* is the same plant six days later. Joints 1 and 2 had already made their growth and were the some height in *B* as in *A*. Joint 3 had not mode full growth in *A*, therefore it grew a little more as shown in *B*. Young seedhead was just emerging above joint 4 in *A*. Six days later joint 4 had reached maturity. The seedhead hod olso broken farther through the boot and both boot and seedstolk had elongated. Old leof blades remained the same length but auxiliary shoots ond leaves between joints 1 and 2 and 2 and 3 had increased in length.

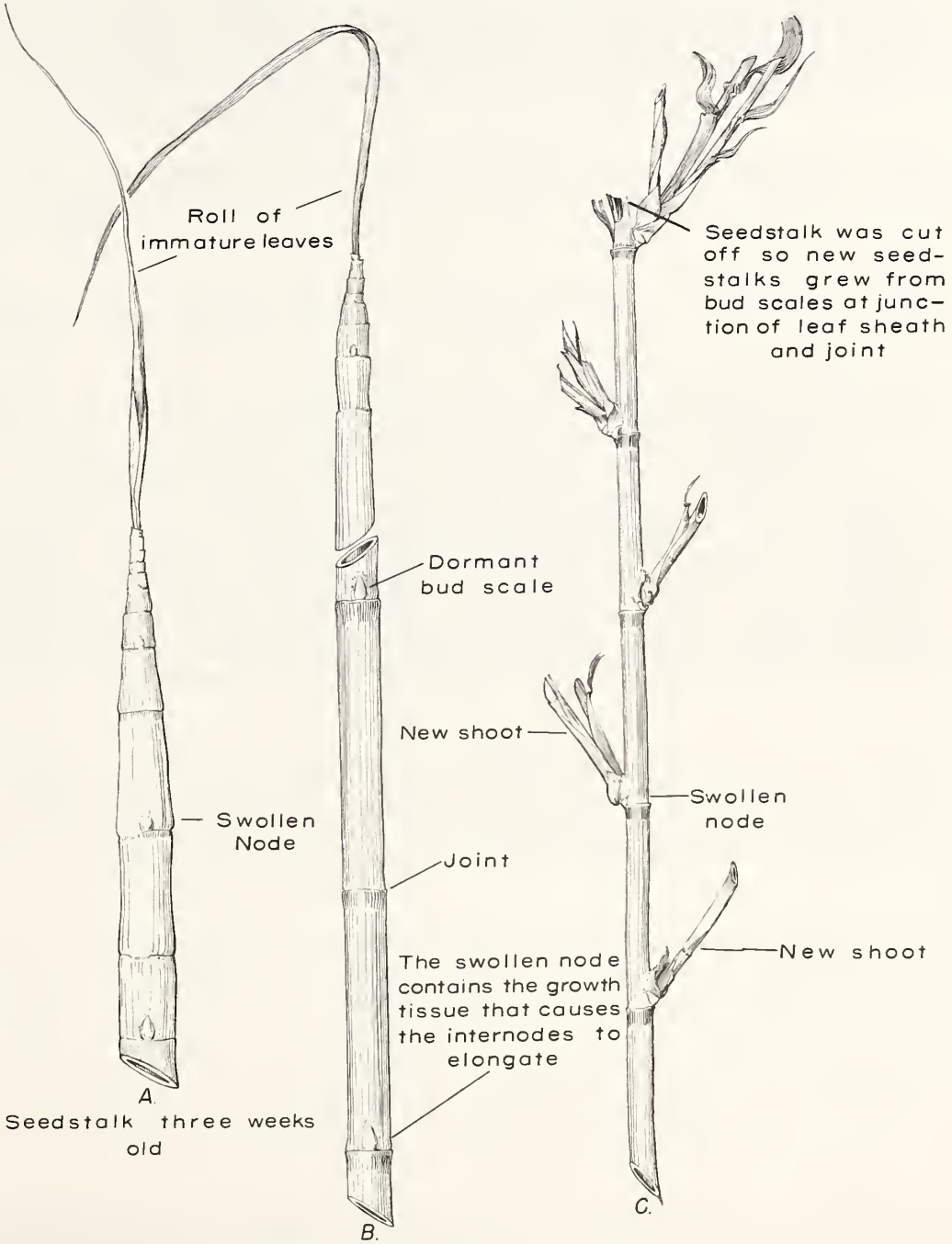


Available sizes
8"X10½"—20"X24"

THREE DEFOLIATED SEEDSTALKS OF GIANTREED

Arundo donax

SHOWS HOW A GRASS GROWS FROM THE ACTIVE TISSUE AT THE SWOLLEN NODE



A–Shows the telescoping of joints of a young plant and *B*, the elongated stem of an older plant that is still growing as noted by the telescoping of joints toward the tip. *C*–Top of growing grass was cut off and new stems grew from the dormant buds at the joints.

Available sizes
8"X10½" – 20"X24"

G.L.B 9-3-47 4-L-5764

The latent growth tissue which is usually sheathed and strengthened at the base of the leaf may again become active and lengthen the stem. This explains how the seed stalks of grass, which are borne on the stem terminus, become elevated far above the boot.

The versatile latent growing tissue of the lower node serves the useful purpose of helping blown down or lodged grasses regain a partial upright habit. Cells elongate on the lower side of the nodes of lodged stems and force them upward at an angle.

Water assumes the vigor role in stem elongation and leaf expansion, and light the larger part in the production of dry matter on sunflowers (Clements and Lang, 1936).

This upthrusting of new grass from the crown bud is described in eloquent narrative by Joseph E. Wing (1911) as follows:

"Now the blades of grass thrust keenly through the soil, burnished and glistening. It is as if spring marched into the land with an army with banners. Grass is the most common and least salient of the phases of nature. It does not lift itself into the vision like the forest. It does not offer an everchanging panorama like the sky. It has no dramatic violence like the sea. Yet nothing gives a deeper sense of the overwhelming power of nature than the silent upgushing of this rich, spreading tide of green. The power that swings the sun in a leash is not mightier than this which slowly and secretely urges the grass into the upper air. Indeed, is it not the same power? There is not a nobler symbol in nature of the mystery of renewal, the mystery of life, than the coming of the grass."

Grasses, like all living things, grow, maintain, and reproduce themselves. The life processes are largely perpetuated through the translucent protoplasm interlining the plant cells. Various grass species have inherent differences in the nuclear protoplasm and each develops and increases its kind in accordance with its inheritance.

In the grass family of the world, there are about 510 genera which have been segregated into 14 tribes. According to Hitchcock's Manual of Grasses (1935), all tribes are represented in continental United States, except Alaska. His manual lists 159 genera and 1,100 species of which 44 genera and 151 species are introductions from the Eastern Hemisphere. There are usually 75 to 200 species in a given locality, but one dozen or less generally make up 75 to 90 per cent of the forage that local livestock eat, and are the first ones that need to be learned.

Plants and animals are now most often classified into kinds or species according to similarity of form and structure. With animals, the family Bovidae, for example, is represented by the following groups of species called genera: Bison and cattle (Bos), goat (Capra), and sheep (Ovis). These genera resemble each other in several ways and appear to have originated from the same ancestral stock in recent geologic times. With

plants the kinds or species, genera and families are now most often grouped naturally according to the arrangement, form, and structure of the floral parts. Body form and structure are relatively unimportant. For example, in the rush genus, Juncus of the family Juneaceae, the stem and leaves look like many members of the sedge family (Cyperaceae) but the floral parts closely resemble those of the lily family (Liliaceae). Therefore, we say the rushes are more closely related to the lilies than to the sedges.

As Hitchcock (1935) points out, "The species is the unit of classification. For example, the white oak, red oak, black oak, and other kinds or species of oak, belong to the genus Quercus, all the species of which have one character in common -- the acorn. The oak genus, the beech genus, the chestnut genus, and a few allied genera are grouped together in one family."

In the grass family, some genera like the bluegrass (Poa), panic grasses (Panicum), and wheat grasses (Agropyron) have numerous species while genera like (Munroa) false buffalograss and (Buchloe) buffalograss have only one species each. While botanists have classified plants by their flowers, the range manager must learn to tell individual plants by differences in leaves, stems, or roots because flowers are only present a short time and often plants are grazed so closely that they seldom produce flowers or visible seed or fruit.

Also, grasses have been classified into a number of other groupings that help to distinguish the ones that are similar in size, feeding and soil conservation values, growing needs, and various other important considerations. These are listed and described as follows:

Tall grasses range in height from 5 to 8 feet or more. They are most abundant in wet valleys, stream edges, in the plains and mountains, and in forest openings from the Mississippi River east. Some of the tall grasses of America are: big bluestem, Indiangrass, switchgrass, sandreed, giant-reed, sleepygrass, cordgrass, gama grass, in central and eastern United States; and sacaton in the Southwest; and giant wildrye in the central and northern Rocky Mountains plateaus. Some of the taller grasses are: bamboos, common reed, giant and switch cane; and the two that are used considerably in parks, gardens, and home grounds are pampasgrass and giantreed (Arundo donax).

Mid grasses vary from 2 to 4 feet in height. These were once the most abundant native grasses that grew on the primeval or climax grasslands. Belonging to this group are: wheatgrass, Arizona and Idaho fescue, little bluestem, sideoats grama, purple threeawn, and all members of the genus Stipa, excluding sleepygrass.

Short grasses comprise the low-growing and often mat-forming types that are under 18 inches high. Many of them are particularly useful for grazing and for lawns, parks, airports and fairways, and putting greens for golf courses. Some of the best known are: blue grama, curley mesquite, buffalograss, Bermudagrass, Kentucky bluegrass, Sandberg bluegrass, Texas

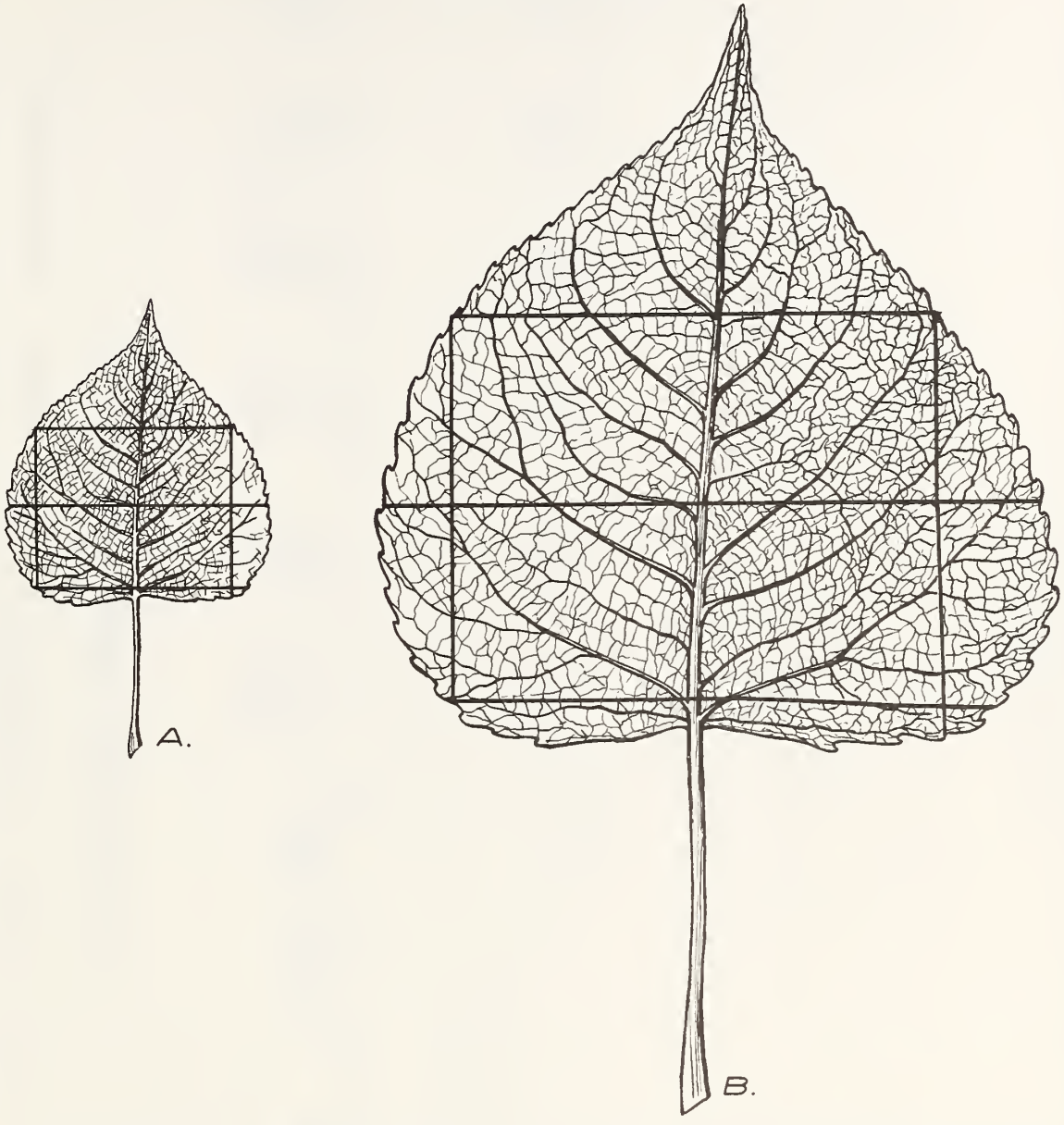
HACKBERRY SEEDLING

Trees grow at the top or terminal bud. Initials cut in a young tree trunk three feet from the ground will remain in that position when the tree is grown.

Available sizes
8"X10½"-20"X24"

9-10-47 4-L-5804

HOW A COTTONWOOD LEAF GROWS



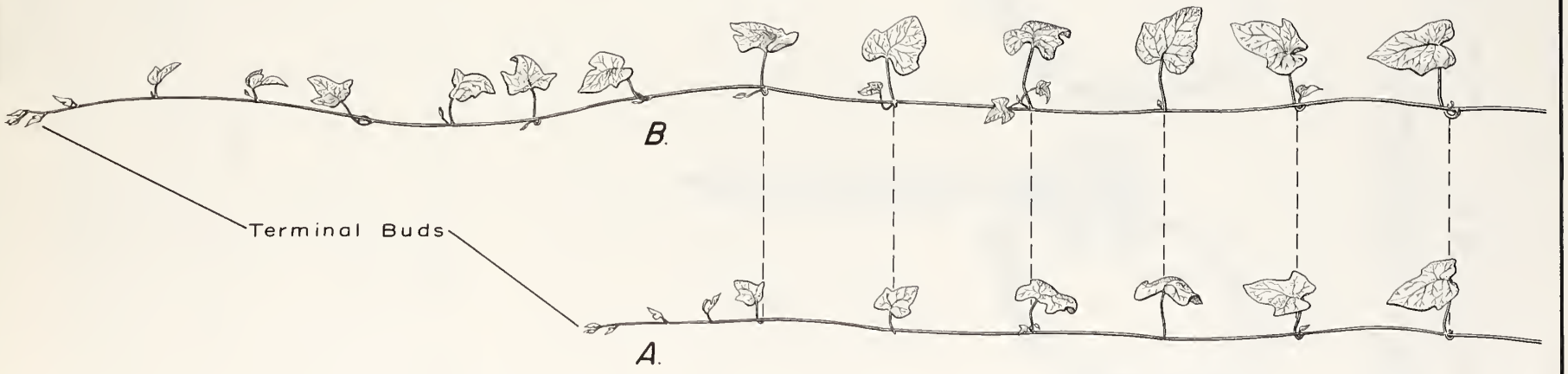
A, Sketch of young cottonwood leaf. *B*, Same leaf at maturity. Leaf grows fairly uniformly by cell multiplication and cell enlargement. Mature leaf has same general shape at maturity it had when young. Lower right side of leaf grew somewhat larger than remainder as noted by the difference in alignment of the original lines.

Available sizes
8"X10½"-20"X24"

L.A.K. 9-9-47 4-L-5801

HOW IVYLEAF MORNINGGLORY GROWS

(*Ipomoea hederacea*)



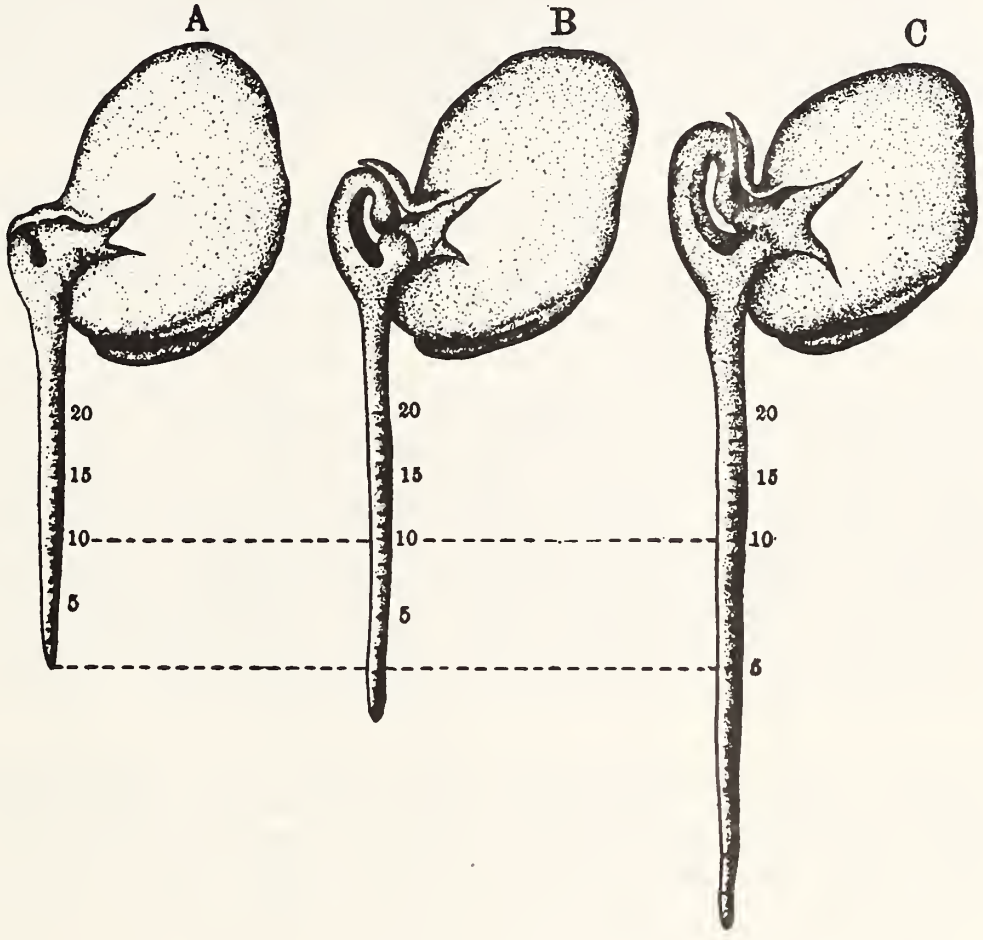
A. Shows size of leaves and length of runner on September 1.

B. Shows how the same plant had enlarged and lenthened by September 3. Growth takes place in the terminal buds.

Available sizes
8"X10½" – 20"X24"

G.L.B. 9-5-47 4-L-5790

ROOT GROWTH OF HORSE-BEAN



Seedling of the horse-bean, *Vicia faba*, showing the amount and location of the growth in (A); after 6 hours (B) and after 24 hours (C).

By F. E. Clements after Pfeffer

Reproduced by:
U. S. DEPARTMENT OF AGRICULTURE,
Soil Conservation Service

Available Sizes
8"X10½" – 20"X24"

9-19-47 4-L-5849

grama, red grama, St. Augustinegrass, carpetgrass, and bentgrass.

Cool season grasses are those that grow in the winter, early spring or late fall. They have special economic significance because they provide a cheap source of protein and carotene during the fall and early spring periods when such feeds are at a premium for livestock. In extremely cold climates even the cool season grasses are forced into dormancy by cold winter weather from the mid-latitudes north. But, winter-growing tendencies increase in south latitudes where moisture and other conditions are also favorable.

To this important group belong the wheatgrasses, ryes, barleys, and oat grasses, both wild and domesticated, as well as the fescues, bluegrasses, wintergrass, and several bromes. These grasses are distributed throughout the cool temperate regions of the globe. A notable characteristic of this group is their tendency to bloom and mature seed before or shortly after the summer solstice, June 21, a period of long days and short cool nights. Many of these plants, like the annual bromes, fescues, wildoats, and Texas wintergrass, survive in south temperate and subtropical regions because they can grow in winter, and seed in May and June, and thereby escape drought and heat. Texas wintergrass escapes summer drought and high temperatures by going partly or wholly dormant. It produces seeds in the normal manner when moderately grazed, but it is very well equipped to survive rigorous grazing because of cleistogenes (Hitchcock, 1935) or seeds which frequently develop in the crown sheaths below the reach of grazing animals (Dyksterhuis, 1946). Even though the mother plant is grazed to death, a new one may grow the next fall in the dead crown of its parent from a seed developed there.

Warm season grasses, as the name implies, generally make their active growth during the frost-free period and develop seed in summer or early fall. These grasses are more tolerant to summer heat and summer drought than cool season kinds, hence they provide better summer grazing because they grow when the cool season grasses usually are dormant, tough, and low in protein and carotene. Some of the more important warm season grasses are: gramas, dropseeds, bluestems, panicums, Rhodes paspalums, lovegrasses, Indiangrass, St. Augustinegrass, carpetgrass, Bermudagrass, corn, sorghums, and millets. Many warm season grasses develop seed during the frost-free period, generally from July to September, but there are exceptions like tobosa, galleta, alkali sacaton, silver bluestem, buffalograss and others which flower in June or earlier.

In snowless south latitudes many of these warm season grasses assume cool season habits. Alkali sacaton is a cool season grass in the subirrigated meadows of the Southwest but is a warm season species in colder Wyoming. Basal leaves of little bluestem stay green all winter in the moist sandy areas of the Texas Gulf Coast; sideoats grama has green basal leaves during moist warm winters of the southern edwards plateau of Texas and northern Mexico. The crown leaves of blue grama and buffalograss remain green in the southwest where winter moisture is adequate. Dallisgrass

usually grows all winter in the subtropical Gulf Coast areas of United States that lie east of the Trinity River in Texas, but it cannot survive cold Colorado or Dakota winters.

Warm season grasses grow best where rainfall is fairly well distributed during the summer -- a time when they make their major growth and develop seed. They are seldom found on the Pacific Coast where the major rainfall is in winter. Cool season grasses abound where fall, winter, and spring moisture is matched with favorable growing temperatures.

Bunch grasses grow upright, increase from seed, and spread at the base from crown tillers much like stooling wheat. The fescues, needleandthread, spiked wheatgrass, slender wheatgrass, most of the threeawns, and smutgrass are bunch grasses. Little bluestem tends to assume bunch grass characteristics in the Northern Plains on hardlands generally and in the semi-arid southwest but has extensive subsurface shoots in the Gulf Coast regions of Texas and Louisiana.

Sod-forming grasses are equipped to reproduce from seed and from surface runners or stolons or from subsurface stems or shoots called rhizomes or underground stems (Hitchcock, 1935). Some that have stolons are: buffalograss, Bermudagrass, St. Augustinegrass, and black grama. A few that propagate from subsurface shoots are: western wheatgrass, common saltgrass, cordgrass, big bluestem, Indiangrass, sand bluestem, Kentucky bluegrass, Bermudagrass, Texas bluegrass, smooth brome, sandreed and giantreed, Johnsongrass, and several grass-like plants such as: threadleaf-sedge (niggerwool), yellow sedge, and Penn sedge. Studies indicate that where other things are equal, both stolons and rhizomes are most abundant where soil moisture conditions and plant nutrition are best. For example, subsurface shoots from sandreed in South Dakota sand hills were 32 per cent greater than those of the same grass in the more droughty Graneros shale beds adjacent. Under drought conditions of 1937 at Rapid City, South Dakota, only 10 per cent of the buffalograss plants in 20 plots produced stolons. The stolons averaged two inches in length. Under improved rainfall conditions three years later, 95 per cent of the same plants produced stolons and the stolons averaged six inches in length. Twenty smooth brome plants, from a valley site east of Colorado Springs, yielded five times more subsurface shoots by dry weight than did twenty plants taken from the drier ridge adjacent. Yield of forage was four times more in the valley than from the ridge-top.

Annual grasses pass through the dry and cold periods in seed form; there is no living over or accumulation of areal parts and they live only one year. Some of them like rescuegrass, cheatgrass brome, little barley and Mediterraneangrass begin growth in the fall, live over winter, and produce seed and die the next spring. These are called winter annuals. When there is no fall moisture to germinate the seed, they may still grow in the spring if conditions there are right. Spring-sown cereal grains are annuals but become winter annuals when fall sown. Sudangrass, millets, corn and sorghums are annuals. Johnsongrass is an annual in the northern states and a perennial in the southern states.

Perennial grasses begin life each year from rootstalk or crown buds that remain alive in the soil. Of course, the original plants come from seed or sprout from stolons or subsurface shoots. These self-perpetuating types give the most dependable grazing. A landowner that has them is free of the cost, risk, and delay that is associated with sowing annual grasses for grazing. Some of the tame perennial grasses are: timothy, orchardgrass, redtop, smooth brome, Bermudagrass, Dallisgrass, and Johnsongrass. Examples of wild perennial grasses are: Idaho and Arizona fescue, needleandthread, tobosagrass, little bluestem, blue grama, cordgrass, bush muhly, and buffalograss.

Mechanically injurious grasses are those with sharp awns or processes that puncture the skin, eyes, and mouth of animals. The spear-pointed seeds of needleandthread, Texas speargrass, porcupinegrass, New Mexico feathergrass, and tanglehead do thousands of dollars worth of damage to sheep pelts and carcasses each year. The seeds of these grasses, along with those of threeawns, annual bromes, sandburs, wildoat and foxtails (Hordeum), foul the fleeces of sheep and lower the sale value. The spines of foxtail lacerate the mouths of horses, cattle, and sheep. Wads of it lodge between the teeth and jowl, often festering the internal mouth tissues and eroding the jaw bones.

Poisonous grasses (Muenscher, 1939). Several of the sorghums, sudangrass, Johnsongrass, and velvetgrass, under certain conditions, produce enough prussic acid to kill livestock. They are apparently most poisonous when partially dried stalks are cut for feed during drought. Velvetgrass is sometimes poisonous in fresh or wilted state.

Darnel ryegrass, or Lolium temulentum, has been considered toxic since Biblical days, at least. It is an annual grass introduced from the Mediterranean regions of Europe. Darnel ryegrass is supposed to be the tare that is referred to in Bible history which is sown by enemies at night. Opinion varies as to the poisonous principle, some believing that the alkaloid, temuline, is toxic while others claim that it is poisonous only when attacked by the fungus, Endocladium temulentum. Vertigo, sleepiness, and heart ailment are reported to be symptoms. According to reports, ill-smelling annual stinkgrass, a weed pest of farmland, will kill horses. The tall sleepygrass of the Great Plains acts as a narcotic and causes temporary slumbering among horses and sheep but it is not toxic to cattle. Other grasses sometimes are toxic to animals when they become infested with ergot and other fungus diseases.

Hay grasses. The tall and mid grasses generally yield the most hay. The short grasses are usually inferior hay yielders because too much of them grows below the reach of the cutting bar of the hay mower. Of the annual grasses cut for hay, the following are among the most important: cereal grains except corn, sudangrass, millet, and wildoat. The more important perennial hay grasses are: timothy, redtop, orchardgrass, alta fescue, hardinggrass, blue panicum, Rhodesgrass, little bluestem, switchgrass, gama grass, Dallisgrass, smooth brome, Johnsongrass, western wheatgrass, and Indiangrass. Hay is generally best when grass is cut in the booting stage.

Silage grasses. Grasses can be made into good silage; their nutrients are kept more thoroughly stable in silage than in hay. Grass silage can be stored in periods when dry curing of hay is impossible. Where facilities are available to handle it, grass can be gathered, ensiled, and fed more cheaply per acre than dry-cured hay. Grass makes good silage at any stage of growth but most nutriticus silage is obtained when the grass is cut in the late blooming and early dough stage. Greatest yield and quality in corn silage comes from corn cut when the kernels have glazed and begun to harden. Grass silage is being fed in the rations of all kinds and classes of livestock with good results. Extra grass cured as silage is an economical safeguard against famine.

Soil conservation grasses. A thick absorbent cover of grass provides a natural defense to soil against the destructive action of wind and water. The myriads of interlacing grass roots bind the soil together and reinforce it against the scouring force of running water. The crumb-like structure of the soil is maintained under good grass; the soil pores are kept open to absorb water and to ventilate the sub-soils with oxygen and other essential soil gases. The cover of decaying residues mellows the soil, soil pores are kept open; also, the beating rain is broken by the spongy bedding into harmless spray that seeps without destruction into the open soil pores where absorption is immediate.

Mid and tall grasses yield far more leaves and stems for mulching than the short grasses. The brittle leaves of dry short grasses quickly disintegrate in the sun and wind. Also, they are shattered by the hoofs of grazing animals more readily than the mid and tall grasses.

Sod-forming western wheatgrass is one of the better grasses that can be planted for sod flumes or grassed waterways to carry surplus water from spillways, terraces, and drainages. It produces a durable sod that holds against cutting action by water and it springs upright again in a few days after water is through flowing. It will grow through several inches of silt deposits whereas some short grasses are often killed by siltation. Buffalo and blue grama are likewise good for this purpose but are not so good as western wheatgrass. Cordgrass and common saltgrass are particularly good waterway grasses in subirrigated or alkaline sites. Their dense entangling roots make them among the best of the soil conservation grasses where runoff water needs to be controlled. Kentucky bluegrass serves well in the same capacity for the northeastern half of the United States and Bermudagrass is of excellent value for the same purpose in the South and Southeast.

Corn, sorghums, small grains, and sudangrass are serviceable types for wind strip cropping. Rye, particularly, is planted in thin stands to serve as climbing stalks for hairy vetch and other climbing legumes that are used to build up soil fertility. Most grasses have some value in improving soil structure and soil tilth but the deeper rooted mid and tall grasses are generally better soil builders than short grasses. Dr. J. E. Weaver of the University of Nebraska has shown that soil granulation was far more perfect on big bluestem ranges than it was on over-grazed blue-grama range.

In the conservation of plowed land the stalks and straws of domesticated annual grasses are being conserved on or near the soil surface with mulching implements to protect soil from erosion. Cereal grains are often fall planted to protect farmland that is subject to blowing and washing.

Climax grasses are those best adapted to a given climate and soil. They can hold the site against less adaptable plants or invaders. Climax is synonymous with the best. It is a term we should use more as it denotes the highest type of native grassland or top ranking plants in such a grassland. Generally, they occur in combinations that provide maximum soil protection and produce more forage than invading grasses. Some of these climax grasses are more palatable than others, and when grazing becomes unbearably great, the more edible ones are eaten out or become greatly reduced in number and vigor. These are known as grasses that decrease under heavy grazing.* Some of the climax grasses are less palatable to livestock than others, so when the best-liked ones are killed by heavy grazing, the least palatable grasses increase. If heavy grazing is continued, even these less palatable climax grasses disappear or thin out and lose vigor. They are called decreasers.*

*Invading grasses are native or introduced annuals or perennials which colonize areas vacated by climax grasses.

Plant Succession Scale - A Business Method of Determining Range Values

The climax grasses make the best use of soil and water under natural conditions, hence they are indicators of best condition. Other plants indicate degrees of departure from the climax. The latter are at the top of the plant succession scale and at the bottom are the annuals or pioneer plants--the first to occupy bare ground.

Soil is enriched by decaying roots and stems of annuals, and soon plants of higher order replace the annuals. In time, each lower group of plants is succeeded by those higher. However, when the best plants are grazed too much, they are killed off and are replaced by inferior ones.

The plant succession scale can be compared with the graduated scale on a thermometer. Each mark on the thermometer registers a certain degree of temperature. In the plant succession scale, each kind of grass or combination of grasses indicates how near to climax plant development has progressed or how near the annual or lowest stage it has descended.

A man that knows how can tell how good his grassland is by checking the kind and amount of vegetation present. The kind of vegetation indicates

*Costello, 1939; Smith, 1940; Weaver and Hansen, 1941; Dyksterhuis, 1944-1947.

also whether there are enough climax plants left to seed back the range when he manages it correctly or whether these plants will have to be artificially introduced. Condition of both soil and plants provides the soundest basis for determining what future programs are needed to improve his grazing lands.

The vegetation in the plant succession scale has been graded into four range condition classes in order to make it easy to tell how good rangeland is. The illustration, "Four Range Condition Classes in Central Texas", shows how this system helps to classify the basic forage crop of a range on a productive upland site in the bluestem belt of Texas. Only a few of the climax plants and invaders are shown because of limited space. A few key plants can be used to grade ranges according to condition.

The range in excellent condition is one where plants and soil are at their best. Mid grasses and deep-rooted desirable forbs are in command and invaders cannot enter. The range in good condition is on the downgrade due to overuse; mid grasses are thinning out; short grasses are entering, and good forbs are dwindling. The soil cover is still good. Under further range depletion, the cover in the fair condition range thins out and weedy shrubs, grasses, and forbs enter. The higher yielding mid grasses are scarce. Under continued heavy use the good mid grasses are nearly gone and survive largely within the armored branches of shrubs and trees. Annual plants, worthless shrubs, and low quality grasses, like the threeawns, occupy the soil.

Yielding power is lost with each downward grade in range condition. A range in poor condition may be only 1/4 or less as good as one in excellent condition; a fair range is sometimes less than half as good as excellent; and a good range may have lost 1/3 of its productivity.

The mid grasses yield well and produce 40 to 60 per cent more than the invading short grasses. Under heavy grazing the palatable mid grasses are readily killed because their upright growing leaves and stems, the food making parts, are easily in reach of animals. Therefore, they either disappear or become scanty and spindling under intense use. The short grasses that replace them survive under overgrazing somewhat better because they stool so closely to the ground that usually some of the leaves are missed by livestock. Therefore, enough green leaves remain to maintain the grasses but only in state of low vigor and low productivity. Also, not much litter is left for soil conservation. In time even the short grasses are killed by extreme grazing pressure. Their place is taken by plants lower in the succession scale -- the low-grade invaders. Some of the invaders are palatable while they are green but they make poor reserve pasture because their dry stems and leaves disintegrate rapidly. Their flimsy short roots are not good soil binders either.

We need to learn more about grasses and be rewarded by what they mean. The ones in a grazing land now are evidence of past events and indicate what the future holds.

Bibliography

Clements, F. E. and Long, Francis L. (1936), Factors in Elongation and Expansion under Reduced Light Intensity, Carnegie Supplementary Publication #19.

Costello, D. F., Range Ecology, 1939.

Dyksterhuis, E. J., Axillary Cleistogenes in Stipa Leucotrica and their Role in Nature, Ecology 1946.

Dyksterhuis, E. J., Ecologic Basis for Range Condition Classes, Region 4, Range Fieldbook, 1947.

Hitchcock, A. S., Manual of Grasses of the United States, 1935.

Muenscher, W. C., Poisonous Plants of the United States, 1939.

Smith, C. C., The Effect of Overgrazing and Erosion upon the Biota of the Mixed-grass Prairie of Oklahoma, Ecology, July 1940.

Weaver, J. E. and Hansen, W. W., Native Midwestern Pastures, Their Origin, Composition, and Degeneration - Nebraska Conservation Bulletin, University of Nebraska, February 1941.

Wing, Joseph E., Meadows and Pastures, 1911.